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14. ABSTRACT The area studied includes 8.7 miles of the Third Branch of the White River in the town of Braintree, Vermont from the Corporate Limit at Addison County to the Corporate Limit at Orange County. The report provides information about the severity of flooding from the Third Branch of the White River in Braintree, Vermont. This information is intended for use by State, Local, and Regional planners in land use a flood plain management.					
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Section 206
Flood Plain Management Services
Third Branch, White River
Braintree, Vermont

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1.0 INTRODUCTION

1.1 Purpose of the Study

The report provides information about the severity of flooding from the Third Branch of the White River in Braintree, Vermont. This information is intended for use by State, Local and Regional planners in land use and flood plain management.

1.2 Authority

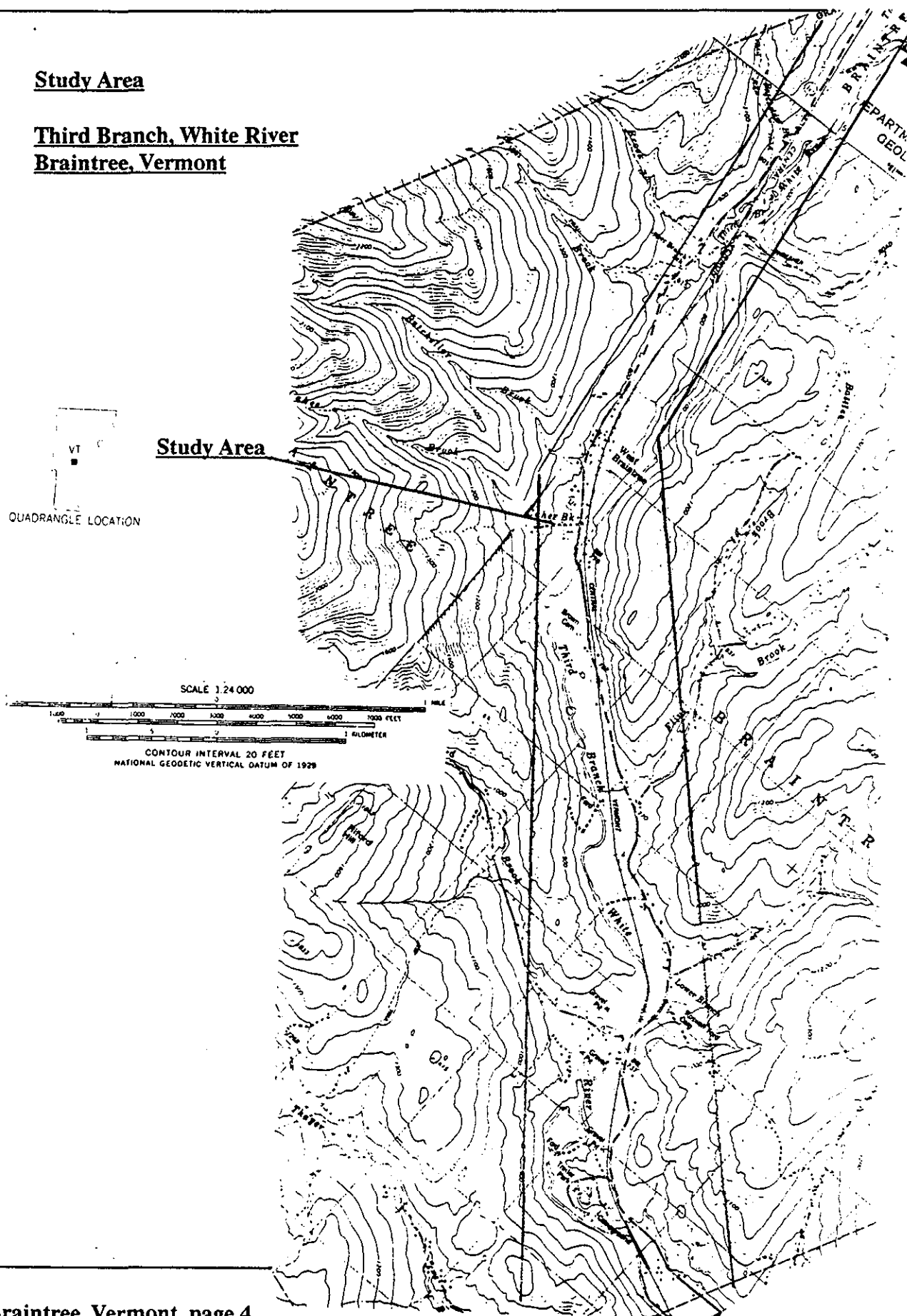
Authority for U.S. Army Corps of Engineers participation in this effort is sanctioned by Section 206 of the 1960 Flood Control Act, (Public Law 86-645), which states:

“...The Secretary of the Army, through the Chief of Engineers, Department of the Army, is hereby authorized to compile and disseminate information on floods and flood damages, including identification of areas subject to inundation by floods of various magnitudes and frequencies, and general criteria for guidance in the use of floodplain areas and to provide engineering advice to local interests for their use in planning to ameliorate the flood hazard...”

1.3 Acknowledgments

The study was conducted by the New England Division, Army Corps of Engineers, under the general supervision of Planning Division Staff.

Third Branch, White River
Braintree, Vermont



2.0 AREA STUDIED

2.1 Scope of Study

The area studied , see previous page, includes 8.7 miles of the Third Branch of the White River in the town of Braintree, Vermont from the Corporate Limit at Addison County to the Corporate Limit at Orange County.

2.2 Community Description

Braintree Vermont is located in the White River Valley in Orange County. It borders Addison County to the Northwest and Windsor County to the Southeast. The Third Branch of the White River flows along State Route 12A and the Central Vermont Railroad from East Granville through Braintree and into Randolph.

2.3 Flood History

The greatest flood on record within the White River watershed was the November 1927 event. The storm originated in the Caribbean in October of 1927 and started moving northward on 1 November. The storm followed a path over western Massachusetts and Vermont causing the greatest flooding on Vermont tributaries of the Connecticut River. Maximum storm rainfall was 9.7 inches recorded at Somerset, Vermont between the third and the fifth of November. There is no recorded discharge information available along the Third Branch but the peak discharge recorded at the USGS gage at West Hartford was 120,000 cubic feet per second (cfs). This is equivalent to a flow rate of 170 cfs per square mile of drainage area.

The second largest flood event occurred during the September 1938 hurricane. In Somerset, VT this storm produced about four inches of rainfall in a three day period. The peak discharge recorded at West Hartford for this event was 47,000 cfs. Comparable flood events to the September 1938 event, but of lesser magnitude, have occurred in the White River Watershed in March 1936 and as recently as December 1973 .

Generally, flooding can occur within the White River watershed during all seasons of the year. While spring is the normal high flow season with increased rainfall and snowmelt, it is by no means the only time of year when flooding is possible, as evidenced by the disastrous flood event of November 1927. The White River watershed is susceptible to various types of floods, but the most severe generally occur as a result of intense rainfall, rather than long duration low intensity events. This is most likely a result of steep valleys and water courses with little natural storage areas. In addition, flooding can result from ice jams coincident with moderate or high flows in the winter and spring.

3.0 ENGINEERING METHODS

Standard hydrologic and hydraulic study methods were used to determine the flood data presented in this study. Flood events of a magnitude which are expected to be equalled or exceeded once on the average during any 10, 50, 100 or 500 year period (recurrence intervals) have been selected as having special significance for flood plain management. These events, commonly termed the 10, 50, 100 and the 500 year floods have a 10, 2, 1 and 0.2 percent chance, respectively, of being equalled or exceeded during any year. Although the recurrence interval represents the long term average short intervals or even within the same year. The analyses reported here reflect flooding potentials based on conditions existing at the time of completion of this study.

3.1 Hydrologic Analysis

Peak 10, 50, 100 and 500 year discharge frequencies for the Third Branch were calculated at pertinent locations. Discharges were transferred from the Randolph Draft Flood Insurance Study to pertinent locations in Braintree. The calculations were made using the drainage area ratio to the 0.7 exponential power. Table 1 summarizes the drainage area peak discharge relationships for the Third Branch White River.

TABLE 1 -- SUMMARY OF DISCHARGES
THIRD BRANCH WHITE RIVER

<u>Location</u>	<u>Drainage Area(sq.mi)</u>	<u>10-Year (cfs)</u>	<u>50-Year (cfs)</u>	<u>100-Year (cfs)</u>	<u>500-Year (cfs)</u>
Braintree/ Randolph Town Line	55.0	5,000	7,500	9,500	14,000
U/S Rillford Brook	46.2	4,700	6,600	8,400	12,000
D/S Dunham Brook	35.0	3,900	5,400	7,000	10,000
Braintree/ Granville Town Line	21.0	2,700	3,800	4,900	7,100

3.2 Hydraulic Analysis

Hydraulic characteristics were analyzed to determine the elevations for the selected 10, 50, 100 and 500 year recurrence intervals. Field surveys and site visits were used to obtain the cross-section information and structural geometry at bridges.

After field inspections of the area, Roughness coefficients, Manning's "n", for the streams were estimated for each cross section. The roughness coefficients for the White River ranged from 0.035 to 0.045 for the channel and from 0.040 to 0.070 for the overbank areas.

The U.S. Army Corps of Engineers HEC-2 water surface profiles computer program, (reference 6), developed the water surface elevations of floods for the selected recurrence intervals shown on the insert sheets and listed in Table 2. Sheet 1 shows the flood profile of computed water-surface elevations for the selected floods. Table 2 lists water surface elevations at various frequencies of occurrence for each cross section surveyed. Initial water surface elevations for the various frequencies of occurrence were based on the slope - area method calculations. These and all other elevations are referenced to the National Geodetic Vertical Datum (NGVD) of 1929. Exhibit 1, page 9, describes selected reference marks and their elevations.

Although ice jams or debris blockage may raise flood elevations given here, the hydraulic analysis for this study is based only on unobstructed flow. This assumption must be considered in evaluating the flood elevations shown on the profiles.

Spacing of cross sections used in the HEC-2 water surface profiles computer run depended on monetary constraints and the size of the study area. Due to the relative consistency of cross section shape, the wide spacing did not present a problem. The typical cross section included as an exhibit, page 12, shows an average channel shape.

The maps used for delineating the 100 and 500 year floodplain boundaries were USGS maps with 20 foot contour intervals, referenced in the Bibliography. The floodplain boundaries have been superimposed on the State of Vermont's official base maps, inserts at the end of this report. Discrepancies in the stream may occur due to minor differences in the maps. The flood profile, first insert, should be consulted when questions arise because of its greater accuracy.

4.0 FLOOD PLAIN MANAGEMENT

4.1 Flood Boundaries

This study uses the 100 year flood as the base flood and the 500 year flood to indicate additional areas of flood risk. Sheets 1 through 3 show these 100 and 500 year flood plain delineations using elevations determined at each cross section. Between cross sections, the flood boundaries were interpolated using 20 foot contour USGS topographic maps. If the 100 and 500 year flood boundaries are either close together or co-linear, the sheets show only the 100 year boundary. Small areas, such as islands may lie above the flood elevations. These areas are not subject to flooding however, because of the map scale limitations, they are not shown.

4.2 Floodways

Encroachment on the floodplain, such as artificial fill, reduces the flood carrying capacity of rivers, increases the flood heights of streams and increases flood hazards in areas beyond the encroachment itself. One aspect of flood plain management involves balancing the economic gain from flood plain development against the resulting increase in flood hazard. The concept of a floodway is used as a tool to assist local communities in this aspect of flood management. Under this concept, the area of the 100 year flood is divided into a floodway and a floodway fringe. The floodway is the channel of a stream, plus any adjacent flood plain areas that must be kept free of encroachment in order that the 100 year flood may be carried without substantial increase in flood heights. Minimum standards limit such increases in flood heights to 1.0 foot, provided that hazardous velocities are not produced. Floodway delineation is shown on the inserts at the back of this report. Table 2 compares the with and without floodway water surface elevations and lists pertinent data for each cross section, including cross section width, area and mean velocity of the flow at the cross section.

TABLE 2 - FLOODWAY DATA
THIRD BRANCH WHITE RIVER

<u>Cross</u> <u>Section</u>	<u>Width</u>	<u>Section</u> <u>Area</u>	<u>Mean</u> <u>Velocity</u>	<u>Water Surface Elevation</u>		<u>Difference</u>
				<u>With</u> <u>Floodway</u>	<u>Without</u> <u>Floodway</u>	
1	87.	953.	10.0	675.6	674.6	1.0
2	214.	1749.	5.4	680.1	679.5	.6
3	467.	1587.	6.0	683.9	683.0	.9
4	147.	1313.	7.2	687.0	686.1	.9
5	153.	1360.	7.0	691.9	691.1	.8
6	103.	657.	14.5	707.6	707.3	.3
7.1	64.	530.	15.8	713.1	713.0	.1
7.2	85.	989.	8.5	717.7	716.9	.8
7.3	64.	804.	10.4	717.5	716.6	.9
7.4	81.	849.	9.9	717.9	716.9	1.0
7.5	64.	837.	10.0	717.9	717.8	.1
7.6	64.	855.	9.8	718.2	718.0	.2
8	380.	1207.	7.0	731.2	730.2	1.0
9	450.	3970.	2.1	733.4	732.4	1.0
10	52.	483.	17.4	731.0	731.1	-.1
12	150.	1360.	6.0	743.9	743.0	.9
13	156.	1147.	7.1	746.9	746.4	.5
14	310.	1640.	4.9	750.3	749.6	.7
15	150.	645.	12.6	757.3	756.8	.5
16.2	106.	939.	8.6	760.5	759.5	1.0
16.3	106.	939.	8.6	760.3	759.6	.9
16.4	106.	959.	8.4	760.7	759.9	.8
16.5	106.	959.	8.4	760.7	759.9	.8
17.1	86.	708.	10.9	763.8	763.7	.1
17.2	86.	863.	8.9	765.6	765.2	.4
17.3	86.	825.	9.3	765.6	765.1	.5
17.4	86.	836.	9.2	765.7	765.3	.4
17.5	86.	879.	8.8	765.8	765.4	.4
17.6	86.	899.	8.6	766.1	765.9	.2
18	220.	1406.	5.3	770.6	769.7	.9
19	108.	753.	10.2	774.5	773.5	1.0

Floodway Tabulation, cont.

<u>Cross</u> <u>Section</u>	<u>Width</u>	<u>Section</u> <u>Area</u>	<u>Mean</u> <u>Velocity</u>	<u>With</u> <u>Floodway</u>	<u>Without</u> <u>Floodway</u>	<u>Difference</u>
19	108	753.	10.2	774.5	773.5	1.0
20	366.	1730.	4.5	780.8	779.9	.9
21	96.	553.	12.7	786.1	786.4	-.3
22	107.	876.	7.9	793.3	792.5	.8
24.1	82.	490.	14.1	795.2	795.2	0
24.2	82.	710.	9.7	797.9	797.9	0
24.3	207.	718.	9.6	797.9	797.9	0
24.4	231.	774.	8.9	798.4	798.4	0
24.5	82.	752.	9.2	798.4	798.4	0
24.6	82.	782.	8.8	798.9	798.8	-.1
25	254.	918.	6.5	818.8	818.0	.8
28	179.	1229.	4.9	825.7	824.8	.9

**TABLE 3 - TABULATION OF CALCULATED WATER SURFACE ELEVATIONS
THIRD BRANCH WHITE RIVER**

<u>Cross Section</u>	<u>Recurrence Interval</u>			
	<u>10 Years</u> (ft, NGVD)	<u>50 Years</u> (ft,NGVD)	<u>100 Years</u> (ft,NGVD)	<u>500 Years</u> (ft,NGVD)
1	671.4	673.2	674.6	677.2
2	676.3	678.3	679.6	682.1
3	681.3	682.3	683.0	684.5
4	684.6	685.6	686.1	686.9
5	688.6	690.2	691.2	692.8
6	705.1	706.4	707.3	709.2
7.1d/s bridge	710.6	711.9	713.0	715.0
7.6u/s bridge	714.3	716.3	718.0	721.7
8	726.8	729.4	730.2	731.0
9	730.4	731.7	732.4	733.5
10	729.8	730.4	732.2	734.8
12	739.9	741.9	743.1	744.6
13	743.8	745.2	746.4	748.3
14	747.6	748.7	749.6	751.0
15	754.5	755.8	756.8	758.8
16.2d/sbridge	757.3	758.6	759.5	760.4
16.5u/sbridge	757.5	758.9	759.9	761.9
17.1d/sbridge	761.0	762.4	763.7	765.7
17.6u/sbridge	762.9	764.5	765.9	768.3
18	767.1	768.5	769.7	772.0
19	772.4	773.0	773.5	774.4
20	778.3	779.2	779.9	780.7
21	784.6	785.5	786.4	787.8
22	790.2	791.6	792.5	794.0
24.1d/sbridge	793.0	794.1	795.2	797.0
24.6u/sbridge	796.0	797.4	798.9	802.8
25	803.9	804.9	806.0	806.7
27	817.2	817.6	818.0	819.2
28	823.3	823.9	824.8	825.8

EXHIBIT 1 - SELECTED REFERENCE MARKS
ALONG THE THIRD BRANCH OF THE WHITE RIVER
BRAINTREE VERMONT

- RM1 - A painted chiseled square on the top of the abutment of the Central Vermont Railroad Bridge over the Third Branch, White River. The chiseled square is located on the downstream NW corner of the bridge. Elevation 695.05.**
- RM2 - A painted spike in a stump located in a clump of 4-6 inch black cherry trees on the right of way fence of the Central Vermont Railroad at a private drive crossing the railroad. Elevation 701.74.**
- RM3 - The top of 5 foot white Central Vermont Railroad triangular mile marker post. Stamped W and painted #48. Elevation 704.73.**
- RM4 - A standard C & GS disk, stamped "E25 1935 and set in the top of a concrete post projecting 6 inches above ground near Central Vermont Railroad right of way fence at the end of Mobile Acres Trailer Home Park. Elevation 705.32.**
- RM5 - A painted chiseled square on top of a ledge outcrop approximately 150 feet NW of railroad crossing entrance to Mobile Acres Trailer Park Campground. Chiseled square approximately level with railroad track and 18 feet from track. Elevation 717.07.**
- RM6 - Painted top of 6" x 8" x 8" upright railroad tie in the right of way fence 35 northerly of W sign. Elevation 721.12**
- RM7 - A standard U.S.G.S. disk set in the top of the first concrete step at the Cassidy dwelling and 6 inches above the ground. Stamped "533 1922 VT 736." Disk is approximately 155 feet southerly of milepost 49. Elevation 736.521.**
- RM8 - A painted chiseled square on top of downstream easterly abutment of a Town Road Bridge over the Third Branch. Elevation 722.19.**
- RM9 - The top of a 6 inch I-beam yellow marker post 49/18 (right hand corner painted) on railroad track by a small unnamed brook. Elevation 730.24.**
- RM10 - A painted chiseled square on top of ledge outcrop flush with the ground on southerly side of railroad tracks nearly opposite red schoolhouse. Elevation 742.51.**
- RM11 - Top of U.S. Sprint underground cable marker post 8/41 at Breezy Maple Farm railroad crossing in the rear of a large single story dairy barn. Elevation 742.49.**
- RM12 - A painted chiseled square on top of ledge by white mile marker post W50. Mile marker post and chiseled square about 10 feet from tracks and level with track. Approximate location is directly in back of White Seventh Day Adventist Church. Elevation 745.49.**
- RM13 - A spike in a 12" elm tree approximately 500 feet southerly CVRR bridge over Flint**

Brook. Elevation 748.52.

RM14 - A painted chiseled square on the Route 12A bridge over Flint Brook. Square located on downstream SE abutment. Elevation 750.99

RM15 - A painted chiseled square on the Route 12A bridge over Flint Brook on top of the abutment on downstream SE end of bridge. Elevation 756.18.

RM16 - A spike in a power pole 40S/ 10/9S located in field by railroad right of way. This is a dead end power pole. Elevation 751.26.

RM17 - A painted chiseled square on top of the base of a railroad crossing signal at Route 12 A, southerly side of Route 12A. Elevation 762.87.

RM18 - A painted chiseled square in ledge level with top of rail at edge of railroad stone ballast opposite Brown Cemetery. Elevation 760.99.

RM19 - A painted spike in the root of a single 24 inch elm tree near field drive. Elevation 758.52.

RM20 - A painted chiseled square on top of the abutment of the Route 12A bridge over the Third Branch. On the upstream NE corner of the bridge. Elevation 764.59.

RM21 - A painted chiseled square on top of the abutment of the CVRR bridge over the Third Branch. On the upstream NW corner of the bridge. Elevation 773.66.

RM22 - The top of a painted bolt on the creosoted timber headwall of a CVRR culvert at Batchellor Brook. On the SW upststream end of culvert. Elevation 779.57.

RM23 - A painted chiseled square on top of the wingwall of the Route 12A bridge over Batchellor Brook. On the SW upstream end of the bridge. Elevation 802.98.

RM24 - A spike in a power pole 142 - 2. Pole is located on a private drive by CVRR crossing to sprint regenerator site and single family dwelling.

RM25 - A painted spot on a 6 inch I-beam marker post 52-24 in CVRR right of way. Top left corner. Elevation 781.23.

RM26 - The top of a CVRR spike at the base of the RR switch, (green marker sign). Switch located at field drive crossing of RR. Elevation 783.98.

RM27 - A painted spike in a timber barricade at the end of field drive crossing of CVRR. Field drive is located opposite L shaped two story WF house, one L painted red, the other unpainted. Elevation 788.51.

RM28 - A painted chiseled square on upstream wingwall of CVRR bridge over Dunham Brook on SW end of bridge. Elevation 791.66.

RM29 - A painted chiseled square on top of curb at upstream SW end of Route 12A bridge over Dunham Brook. Elevation 815.64.

RM30 - A painted chiseled square on top of the abutment of the CVRR bridge over Brackett Brook on the upstream SW corner of the bridge. Elevation 793.80.

RM31 - A painted chiseled square on top of the curb on the upstream NW end of the Route 12A

bridge over Brackett Brook. Elevation 817.31.

RM32 - A standard Vermont Tablet set in the top of the curb of Thresher Road bridge over the Third Branch on the downstream side of the bridge. Elevation 802.36.

RM33 - The top of a painted bolt on the upstream NW end of the CVRR bridge over Betchelder Brook. Elevation 802.19.

RM34 - A painted chiseled square on the top of the wingwall of the Route 12A bridge over Betchelder Brook on the downstream NE end of the bridge. Elevation 813.54.

RM35 - A painted chiseled square on the top of the abutment of a town road bridge over the Third Branch on the upstream NW end of the bridge. Elevation 810.52.

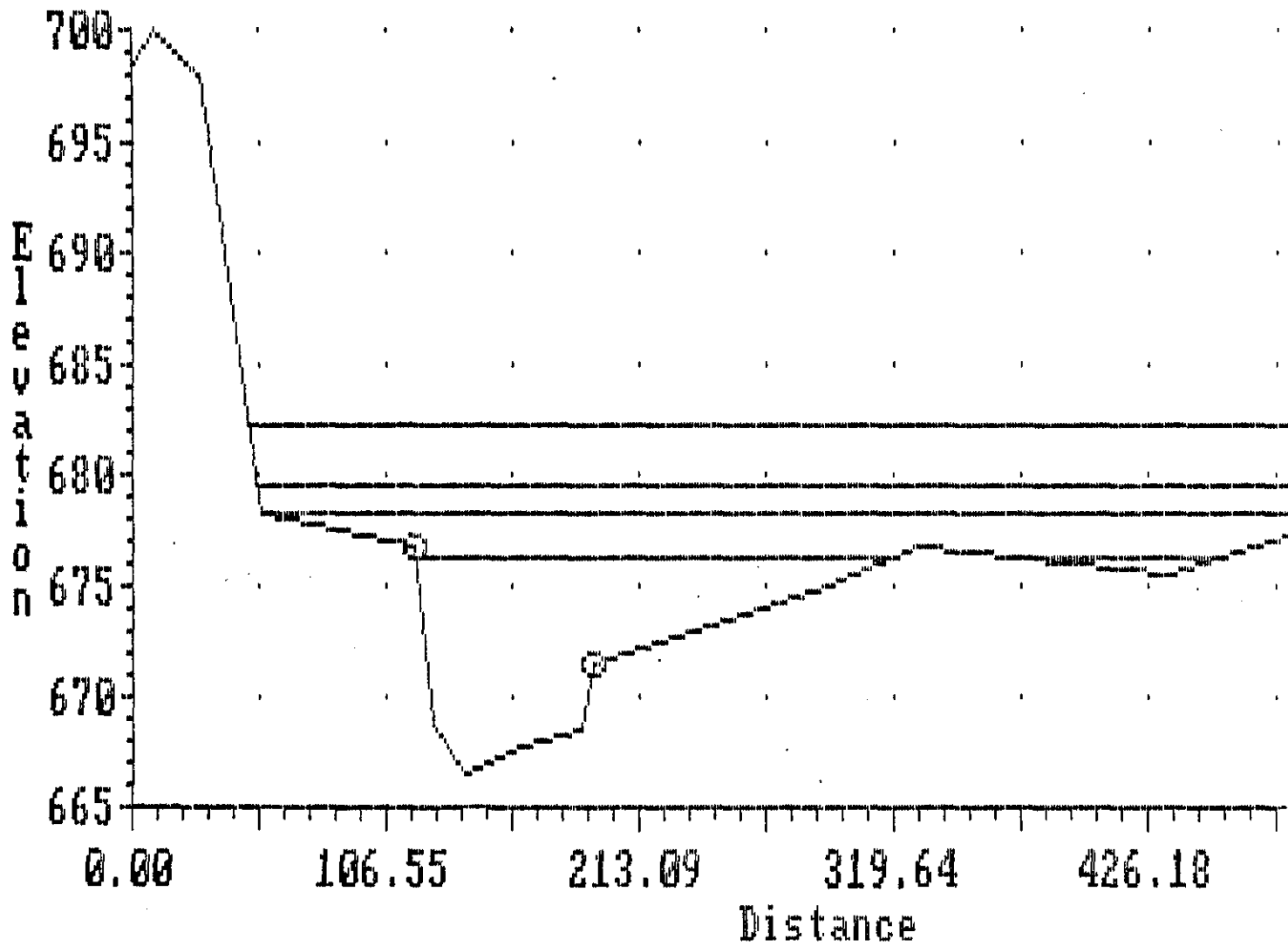
RM36 - A spike in an 8 inch White Birch on the bank of the Third Branch. Elevation 816.92.

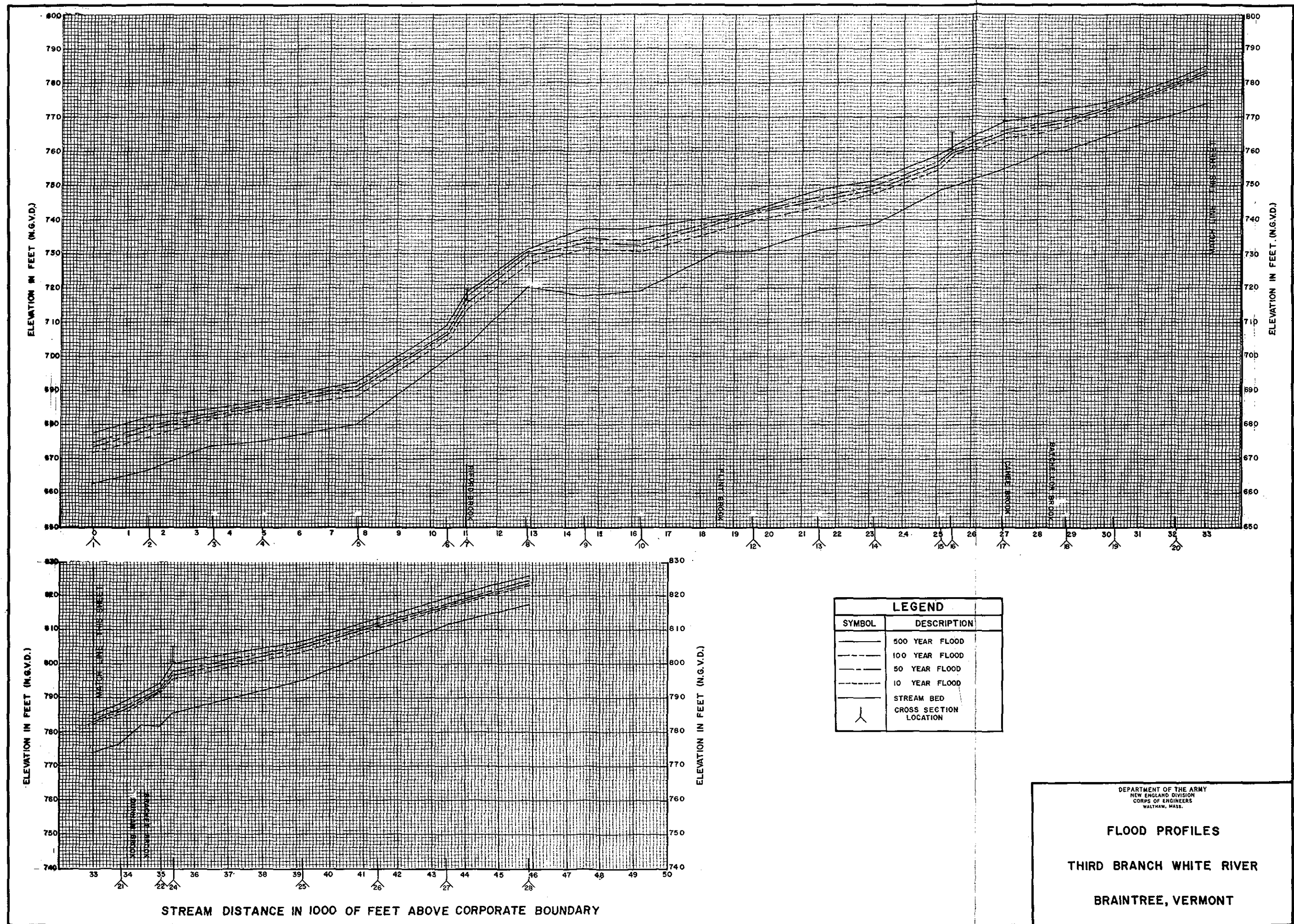
RM37 - A spike in an 8 inch apple tree on the river side of CVRR nearly opposite the Town Line marker on Route 12A. Elevation 825.51

RM38 - A chiseled square on top of the abutment of the CVRR bridge over the Third Branch on the upstream SW end of the bridge. Elevation 840.06.

RM39 - A standard C & GS standard disk stamped "B25 1935" set in ledge 8.2 feet east of the east rail of CVRR track, in the top of the shelf of a rock cliff, and 3-1/2 feet higher than the track. Elevation 848.15.

EXHIBIT 2 TYPICAL CROSS SECTION
Third Branch, White River



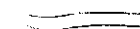

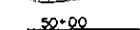

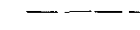
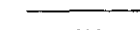
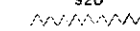


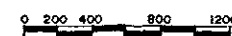


NOTES:

- 1 THE BASE MAPS ARE THE STATE OF VERMONT'S OFFICIAL BASE MAPS (AERIAL PHOTOS).
- 2 ALL ELEVATIONS ARE IN FEET ABOVE THE NATIONAL GEODETIC VERTICAL DATUM OF 1929 (NGVD).

LEGEND

-  100-YR. FLOOD LIMITS
-  500-YR. FLOOD LIMITS
-  STATION IN FEET (E.G. 5000 FEET) UPSTREAM FROM RANDOLPH/BRAINTREE CORPORATE LIMIT (FOR THIRD BRANCH)
-  FLOODWAY BOUNDARY
-  CROSS-SECTION
-  100-YEAR FLOOD ELEVATION
-  REFERENCE MARK



DEPARTMENT OF THE ARMY
NEW ENGLAND DIVISION
CORPS OF ENGINEERS
WALTHAM, MASS.

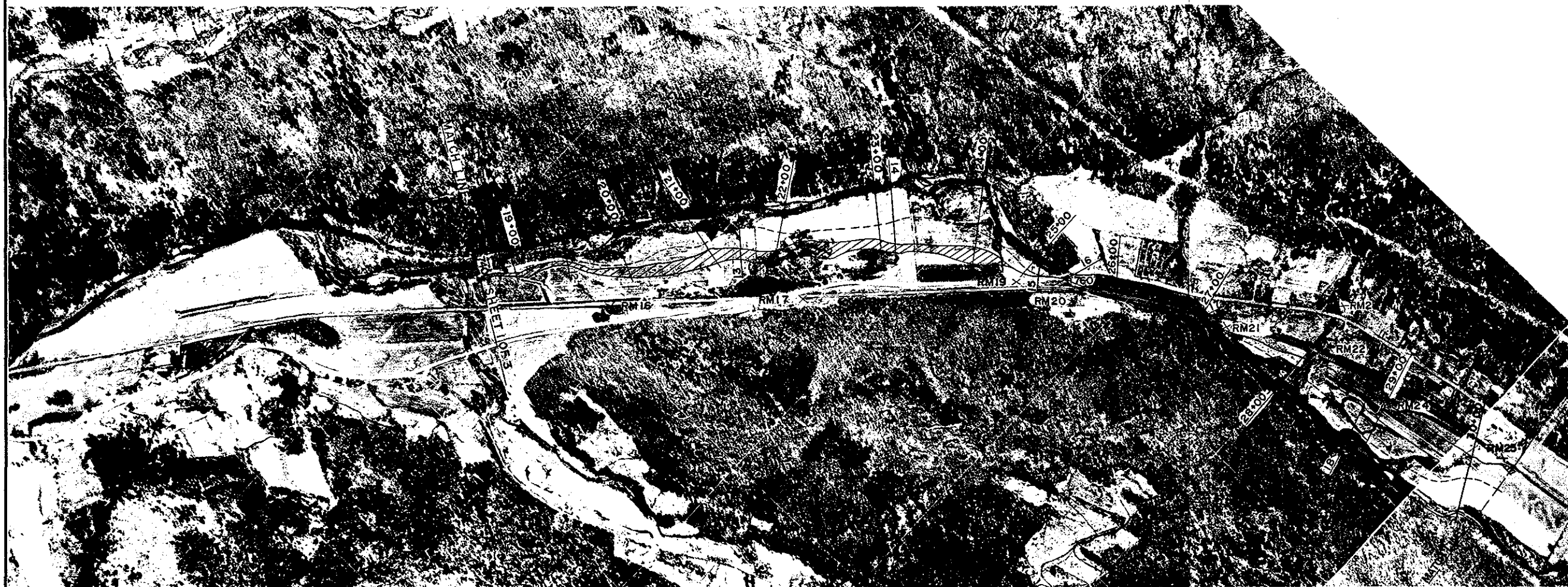
FLOOD PLAIN BOUNDARIES

THIRD BRANCH WHITE RIVER

BRAINTREE, VERMONT

MAY 1990

SHEET 1 OF 3



NOTES:

1. THE BASE MAPS ARE THE STATE OF VERMONT'S OFFICIAL BASE MAPS (AERIAL PHOTOS).
2. ALL ELEVATIONS ARE IN FEET ABOVE THE NATIONAL GEODETIC VERTICAL DATUM OF 1929 (N.G.V.D.)

LEGEND

- 100 - YR. FLOOD LIMITS
- 500 - YR. FLOOD LIMITS
- 50+00 STATION IN FEET (E.G. 5000 FEET) UPSTREAM FROM RANDOLPH/BRAINTREE CORPORATE LIMIT (FOR THIRD BRANCH)
- FLOODWAY BOUNDARY
- CROSS-SECTION
- 920 100-YEAR FLOOD ELEVATION
- RM REFERENCE MARK



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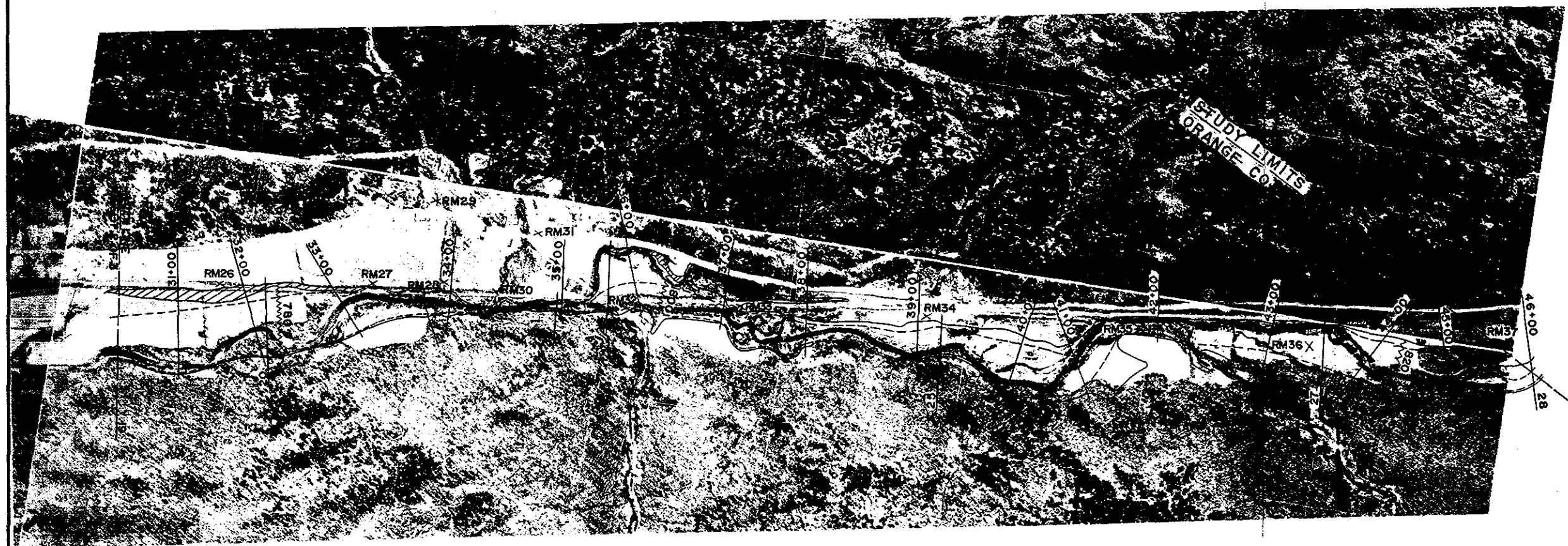
FLOOD PLAIN BOUNDARIES

THIRD BRANCH WHITE RIVER








BRAINTREE, VERMONT

MAY 1990

SHEET 2 OF 3



LEGEND

-  100-YR. FLOOD LIMITS
-  500-YR. FLOOD LIMITS
-  50+00 STATION IN FEET (E.G. 5000 FEET) UPSTREAM FROM RANDOLPH/BRAINTREE CORPORATE LIMIT (FOR THIRD BRANCH)
-  FLOODWAY BOUNDARY
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FLOOD PLAIN BOUNDARIES

THIRD BRANCH WHITE RIVER

BRAINTREE, VERMONT

MAY 1990

SHEET 3 OF 3